

ACTiSYS IrDA Product Line

ACTiSYS IrDA Computer, Printer and LAN Adapters

100M: IrDA Printer Adapter

The official IrDA golden samples to be used at each IrDA accredited Test Lab around the globe

- IrDA **accredited Test Lab** around the globe. Attached to and works well with any parallel printers.
- IR wireless printing directly from your IrDA devices.
- You can still print directly from desktop or LAN by connecting the printer cable to the built-in pass through connector.
- Automatic switch between these two printing options.
- LED's indicate transmission speed and printing status.

220L: IrDA Com-Port Serial Adapter

The official IrDA golden samples to be used at each IrDA accredited Test Lab around the globe.

- IrDA accredited Test Lab around the globe. Easily connects to the serial port on any computer. No power needed!
- Data transfer and record synchronization wirelessly from IrDA portable devices.
- Model already built into Windows 95-IR driver by Microsoft Corp.
- IR distance from 0cm-200cm with no external power!

220LR: Ruggedized IR Computer Adapter

- Endure tough weather or environment!
- Operates under extended temperature range and meets NEMA specification.

2000L: IrDA motherboard Adapter

- Plugs easily into IrDA-FIR ready desktop PC motherboard.
- Gives you the full IrDA speeds from 9.6K to 4M bps!
- Back panel bracket/cable assembly included.

2000B/L: IrDA ISA-Bus Add-On Card with Adapter

- Plugs into any desktop PC motherboard. IrDA adapter included.
- Gives you the full IrDA speeds from 9.6K to 4Mbps!

6000B: IrDA LAN Adapter

- Plugs into any node on a LAN network!
- Easy wireless LAN access across from IrDA notebook, up to 4Mbps!

ACTiSYS IrDA Protocol Software Products

Licensed to many major companies. Shown above, our licensees' products include:

From top right: medical monitoring device, digital camera, smart phone.

From top left: portable printer, instrument, handheld PC, PDA, meter.

Other licensees in two-way pager, industrial terminal, consumer device, etc.



I-1.0 (IR960SW): IrDA-1.0 Primary-Station Protocol Stack

- IrLAP, IrLMP, IAS and optional Tiny TP, IrCOMM. IrTelecom, IrTran-P, etc.
- For PDA, digital camera, handheld data terminal, palmtop computer, smart phone.
- Very tight code, modular design, easy porting and API interface, well supported.
- Small code size (20 - 40K bytes), well tested and inter-operate with all IrDA devices.



II-1.0 (IR940SW): IrDA-1.0 Secondary Station Protocol Stack

- IrLAP, IrLMP, IAS and optional Tiny TP, IrCOMM. IrTelecom, IrTran-P, etc.
- For printer, pager, docking station, medical device, cell phone, storage devices.
- Very tight code, modular design, easy porting and API interface, well supported.
- Small code size (4-20K bytes), well tested and inter-operate with all IrDA devices.



I-1.1 (IR9600SW): IrDA-1.1 Primary-Station Protocol Stack

- Same as ACT I-1.0 except for higher speeds, IrDA-1.1 (9.6K-4Mbps).



II-1.1 (IR9400SW): IrDA-1.1 Secondary-Station Protocol Stack

- Same as ACT II-1.0 except for higher speeds, IrDA-1.1 (9.6-4Mbps).

ACTiSYS IrDA System Test Tools



9000SW: IrDA-1.1 (9.6K-4M bps) System Test Software

- Effective QC, Engineering diagnostic and efficient production-line test tool.
- Adjustable packet size, # of packets, speeds, test patterns and send/receive/2way.
- Works well with embedded protable IrDA-FIR devices as well as notebook PC.
- Displays error rate of send, receive at each IR speed and DUT's IAS resource.
- Works with ACTiSYS FIR add-on board and adapter, **IR2000B** and **IR2000L**.



903SW: IrDA-1.1 (9.6K-115.2K bps) System Test Software

- Same as IR9000SW test software except for IrDA-1.0 (9.6K-115.2Kbps.)
- Ideal for testing SIR digital camera, pager, smart phone, printer, medical device.
- Works with ACTiSYS IrDA RS232 adapter, IR220L on the reference station.



3000M: Hand-held IrDA-1.1 (9.6K-4M bps) System Tester

ACTiSYS IrDA Standards

- [IrDA Standards I IrDA-1.1 \(FIR\) PROTOCOL SYSTEM INTEGRATION AND TESTING](#)
- [IrDA Standards II IrDA PROTOCOL INTEGRATION AND SYSTEM TESTING](#)
- [IrDA; An Introduction to the IrDA Standard and System Implementation](#)

ACTiSYS IrDA Printer Adapter

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- The **ACT-IR100M** gives the user IR wireless printing from mobile computers and PDAs. You can also print directly from desktop PC or LAN by connecting the printer cable to the ACT-IR 100M.
- It is compatible with IrDA-1.0 at communication speeds programmable at 9.6, 19.2, 57.6, 115.2K bps and a distance of 100cm and beyond. It is well suited for all IR wireless printing applications.
- It works well with any parallel printers. You can print wirelessly from any IrDA-capable notebook PC, smart cellular phone, PDA, HPC and industrial data terminal, running appropriate IrDA application software.
- It has built-in printer pass-through connector and very compact IrDA protocol. Powered by AC adapter (included).
- It automatically switches between IR wireless or cable-based printing. Indicator light flashes at IR transmission speed and indicates printing status.
- IR head can be easily attached to any convenient desktop location using Velcro.



Technical Specifications

SUB-CARRIER/IR INTERFACE:

Compatible with IrDA-1.0 at speeds of 9.6K, 19.2K, 57.6K, 115.2K bps.

BUILT-IN SOFTWARE:

IrDA protocol software necessary for secondary station communication.

Printer flow control.

COMMUNICATION DISTANCE:

Between 0cm and beyond 100cm.

CONNECTORS:

Built in printer share switch with two CEN36 connectors in a pass through module.

Connects PC to

printer with standard printer cable, and with the addition of an IR wireless printing path.

POWER SOURCE AND CONSUMPTION:

AC adapter (ACT3-128) included.

0.3 W (Peak)

DIMENSIONS/WEIGHT (excluding AC adapter and IR cable/head assembly):

4.0"L x 2.1"W x 0.9"H

102mm x 54mm x 23mm

6.8 oz. (184.4gr.)

Compatible with the following IrDA capable devices:

<u>Notebook:</u>	<u>Software:</u>	<u>Handheld PC/PDA:</u>
All IrDA notebook PC running appropriate IrDA application software.	Windows 95-IR driver 2.0 Windows 98, NT 5.0-IR driver 3.0 Windows CE 2.0 Puma-Tranxite Pro.	Norand, LXE, etc. Sharp Zaurus, Power Zaurus. Psion 3C/Series 5 All Windows CE 2.0-H/PC
<u>Printer:</u>	<u>Cellphone:</u>	
All standard parallel printers.	Nokia 9000, 6110 Alcatel, Sharp PMC	

ACTiSYS IrDA COM-Port IR Computer Adapter

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- The **ACT-IR200L** or **IR220L /IR220L+/IR220LN** attaches to the RS232 serial port of desktop PC to give the user wireless data transfer for record synchronization, file back-up and network access, directly from IR-capable notebook PCs and PDAs. No external power is needed!
- These adapter models have already been built into Windows 95 and many PC link software for IR-capable PDA, H/PC, data terminal and portable medical devices! No additional IR driver installation is needed!
- **IR200L** is compatible with multiple IR standards; ASK (500KHz) used by Sharp's Wizard and Zaurus, Apple's Newton, and IrDA-1.0 used by many IrDA capable notebook PCs, PDAs, etc. No external power is needed!
- **IR220L** is IrDA-1.0 compatible that has data rates of 9.6, 19.2, 57.6, 115.2K bps. It can reach communication distance of 0cm to 200cm with no external power! It is applicable to any IR communication protocol specifications.
- **IR220L+** is IrDA-1.0 compatible that has data rates of 9.6, 19.2, 38.4, 57.6, 115.2K bps. It can reach communication distance of 0cm to 200cm with no external power! It is applicable to any IR communication protocol specifications.
- **IR220LN** is a RS232 port IR (Non-IrDA) adapter. It is designed to replace the RS232 cable in serial connections at any commonly used data rates up to 115.2Kbps. (It requires to use the ACT-IR220LN on both sides, not just one side.)
- **ACT-IR200L/IR220L/IR220L+/IR220LN:**
 - Infra-Red Wireless Serial InterfaceAdapter.
 - IR head can be easily attached to any convenient desktop location using Velcro.
 - Ruggedized version, IR220LR is also available.



Technical Specifications

SUB-CARRIER/IR INTERFACE:

IR200L: Multi-standard; Compatible with IrDA-1.0, ASK-IR (500KHz) specifications.

IR220L/IR220L+: Compatible with IrDA-1.0 only

COMMUNICATION DISTANCE & SPEEDS:

IR200L: Communication speeds programmable at 9.6, 19.2, 38.4, 57.6, 115.2K bps for IrDA-1.0 mode, and at 9.6, 19.2K bps for ASK mode. It can reach distance of up to 100cm.

IR220L: Communication speeds programmable at 9.6, 19.2, 57.6, 115.2K bps and distance of 0cm to 200cm and beyond

IR220L+: Communication speeds programmable at 9.6, 19.2, 38.4, 57.6, 115.2K bps and distance of 0cm to 200cm and beyond

IR220LN: Same as IR220L plus transfer distance up to 300cm.

CONNECTORS:

An integral 4-ft cable with DB9F connector.

POWER SOURCE:

RS232 port power only. No external power required.

POWER CONSUMPTION:

0.30W(Peak)

DIMENSIONS/WEIGHT:

IR200L/220L/220L+: 60L x 35.5W x 18.0H (mm)

IR220L/220L+: 65.0 gr (2.4 oz)

IR200L: 56.9 gr (2.1 oz)

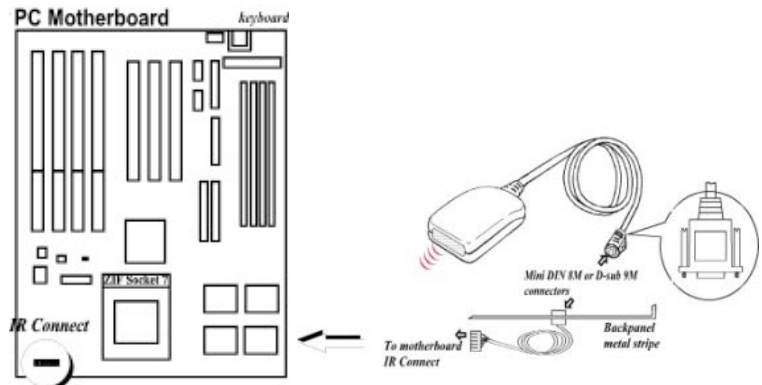
Compatible with the following IR or IrDA capable devices:

<u>Notebook:</u>	<u>Software:</u>	<u>Handheld PC/PDA:</u>
All notebook PC's	Windows 95-IR driver 2.0 Windows98, NT 5.0-IR driver 3.0Windows CE 2.0 Linux Puma-Tranxit Pro	Norand, LXE, etc: Sharp Wizard, Zaurus, Power Zaurus, SE500. Psion 3C/Series 5 Palm Pilot III All Windows CE 2.0-H/PC
<u>Printer:</u>	<u>Cellphone:</u>	<u>Digital Camera:</u>
HP-5MP Laser Printer HP-6P Laser Printer Others	Nokia 9000 Ericsson SH888 / SF888 Alcatel, Sharp PMC	Sony DSC-F1 Sharp VE-LS5 Kodak Others

<u>Desktop:</u>

All desktop PC's

ACTISYS IrDA IR Computer Motherboard Adapter



IR2000L is compatible with multiple IR standards:

- IrDA-1.1: 1.152M, 4MBbps.
- IrDA-1.0: 9.6, 19.2, 38.4, 57.6, 115.2Kbps.
- ASK-SIR/500KHz: 9.6, 19.2, 38.4Kbps
- TV Remote Control: ASK/37KHz.

The only Test Software **IR9000SW on the market!**

- Quickly test and record error rates at all speeds.
- Special IrDA stress test Patterns.
- Can isolate transmission and receiving separately.
- Can easily set packet size and # of packets sent.

It gives multi-media desktop computer an IR command center; TV remote control up to 7 meters, and two-way data transfer up to a speed of 4M bps and distance of 2 meters.

The **ACT-IR210L** and **IR2000L** connects directly to the IrDA-capable motherboard. It gives the desktop computer user IR wireless data exchange directly from IR equipped mobile computers and PDA's and remote control.

Two Models:

ACT-IR210L: For IrDA-1.0 (9.6K-115.2Kbps) and TV remote control.

ACT-IR2000L: For IrDA-1.0, IrDA-1.1, ASK-SIR and TV remote control.



Technical Specifications

ACT-IR210L	ACT-IR2000L
SUB-CARRIER/IR INTERFACE: - IR210L: IrDA-1.0 and TV remote control compatible. COMMUNICATION DISTANCE & SPEED: - IR210L: Communication speed at 9.6, 19.2, 38.4, 57.6. 115.2Kbps, and a distance of 0 cm-200 cm and beyond.	SUB-CARRIER/IR INTERFACE: - IrDA-1.0 Compatible. - IrDA-1.1 Compatible - ASK-SIR Compatible - TV Remote Control Compatible COMMUNICATION DISTANCE & SPEED: - IrDA-1.0 : 0-200cm; 9.6K-115.2Kbps - IrDA-1.1: 0-100cm; 1.152M, 4Mbps - ASK-SIR: 0-100cm; 9.6K-38.4Kbps - TV-Remote: 0-600cm; ASK / 37KHz
CONNECTORS: - An integral 4-foot cable with DB9M or DIN8M connector. - IRhead can be attached to any convenient location using Velcro. POWER SOURCE AND CONSUMPTION: - No external power source needed (Both Models)	DIMENSIONS / WEIGHT: 51L x 41W x 16H (mm) 2.0"L x 1.63"W x 0.63"H 54gr. (2oz) 0.3W (Peak)

ACTiSYS IrDA ISA-Bus Add-on Card & Adapter



- ◆ The **ACT-IR2000B/L** is an ISA bus board (IR2000B) plus FIR adapter (IR2000L). It is designed to facilitate FIR software and hardware development of wireless infrared communication products. It can also be used as IrDA tester with appropriate test software (e.g. IR9000SW).
 - **IR2000B/L** supports InfraRed Data Association (IrDA) standards; SIR, MIR, and FIR encode/decode for data rate from 9.6 Kbps to 4.0 Mbps.
 - **IR2000B/L** also supports 38 KHz and other ASK modulation/demodulation mode used in many TV, VCR, and home entertainment IR remote controllers (when use **IR2000LC**).
 - **IR2000B/L** provides Mini-DIN 8 connector on the back panel for the proposed IrDA standard of "IrDA Desktop Solution".
 - **IR2000B/L** utilizes National Semiconductor's PC87108A Universal Infrared (UIR) module.
 - **IR2000B/L** compatible with IrDA driver in Windows 95, 98 and NT5.0 Beta release.

Technical Specifications

SUB-CARRIER/ SPEEDS:

IR2000B: Compatible with IrDA 1.1, Full IrDA speed from 9.6K to 4M bps!

IR2000L: Compatible with IrDA 1.1, Full IrDA speed from 9.6K to 4M bps

OPERATING ENVIRONMENT:

Temperature: 0° C to +50°C

Humidity: 0% to 90%, no condensation.

CONNECTORS:

The board has six connectors. The type and function of each connector is shown below:

Connector	Connector Type and Function
J 1	10-pin Header. IRFE with ACTiSYS IR Connector.
J 2	DB9 Female. IRFE with DB9 Connector.
J 3	6-pin Header. General-purpose I/O Signals.
J 4	DB9 Male. UART Connector with Serial Drivers.
J 5	3-pin Header. External Chip Select Input.
J 6	8-pin Mini-DIN. IRFE with Mini-DIN Connector.

POWER REQUIREMENTS:

The IR2000B IrDA ISA-Bus Add-On Card requires +5V, +12V and -12V voltage levels.

DIMENSIONS / WEIGHT:

IR2000B: The 4-Layer NS-PC87108AEB chip based board, 92mm x 166mm.

IR2000L: 61.8L x 35.6W x 18.7H(mm), (2.4"L x 1.4"W x 0.74"H) 56.9 gr (2.1oz.)

ACTISYS IrDA Hand-held System Tester

- Each **ACT-IR3000M** replaces the following:
desktop PC, FIR add-on card and serial adapter, to test FIR/MIR/SIR of various IrDA DUT (Device Under Test).
- Pocket size, battery operated, optional AC adapter. Test status and results indicated by LED's or audio.
- Connecting **IR3000M** to the notebook PC Com port, facing the FIR window, you can now test the FIR function of notebook in a simple loop test! This quick loop test was possible only with SIR before!
- Using one **IR3000M**, you can easily test IrDA-enabled digital camera, PDA, smart cellphone, pager, data terminal, printer, etc.
- Using **IR3000M** and a fixture driven by the second IR3000M, you can easily replace and test many IrDA transceiver modules! This was not possible before !
- One button operation to test both IrDA hardware and default IrDA protocol driver which consists of:
 - * Media busy condition.
 - * Discovery procedure.
 - * Connections at all the data rates supported.
 - * IAS inquiries of DeviceName and IrLMP Support.
 - * Verify Test Frames if the DUT-IrLAP supports it.
 - * Disconnect, go back to Normal Contention Mode and connect at the next supported data rate, make IAS inquiries, exchange test frames, etc.
- Customized IrDA test program can be stored in a flash ROM inside. It can be programmed by connecting IR3000M to the Com port of desktop PC, or can also be controlled and test progress displayed on PC, interactively!
- Also available separately from ACTiSYS: Testing Embedded DUT?
 - * PC software to configure and customize IrDA test program.
 - * PC software to control IR3000M interactively.
 - * FIR Driver support for many IrDA notebook models.
 - * Simplified IrDA stacks for many other device types.



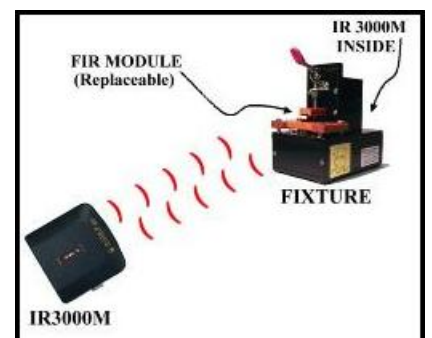
ACT-IR3000M TESTER



Notebook FIR Loop Test



Testing Embedded DUT's



For Transceiver Modules

Technical Specifications

ACT-IR3000M HANDHELD TESTER SIR/MIR/FIR

PHYSICAL LAYER:

- IrDA-1.1/1.0 (FIR/MIR/SIR) compatible.

COMMUNICATION DISTANCE & SPEEDS:

- Communication speeds programmable at 9.6, 19.2, 38.4, 57.6, 115.2 Kbps for IrDA-1.0 mode, and 9.6K to 4M bps for IrDA-1.1 mode. It can reach distance of 0cm to 100cm.

CONNECTORS:

- An integral DB9F connector.

POWER SOURCE:

- 4 x AA battery or AC adapter (Optional)

POWER CONSUMPTION:

- Active: 158 mA (521.4 mW) ; Sleep: 84 mA (277.2 mW) ; Power down: 11uA (36.3 uW)

DIMENSIONS/WEIGHT:

- 2.0"L x 1.63"W x 0.63"H (51mm x 41mm x 16mm) / 6.6 oz.; 175gr.(with batteries)

OPTIONAL:

- PC software to configure and customize IrDA test.
- PC software to control IR300M interactively.
- FIR Driver support for many IrDA notebook models.
- Simplified IrDA stacks for many other device types.

Compatible with the following IR or IrDA capable devices:

<u>Notebook:</u>	<u>Software:</u>	<u>Handheld PC/PDA:</u>
All notebook PC's	• Windows 95-IR driver 2.0 • Windows 98, NT 5.0-IR driver 3.0 • Windows CE 2.0 • Puma-Tranxit pro	• Norand, LXE, 3 COM Palm Pilot III • Sharp Zaurus, Power Zaurus, HHP • TELXON, Symbol, Psion Series 5 • All Windows CE2.0-H/PC
<u>Printer:</u>	<u>Cellphone:</u>	<u>Digital Camera:</u>
HP-5MP Laser Printer HP-6P Laser Printer	Nokia 9000, 6000 series Motorola PageWriter 2000	Sony DSC-F1 Sharp VE-LS5

ACTiSYS IrDA Protocol Software

- Compatible with Windows 95, Puma-TranXit, HP-5MP laser printer IrDA software drivers
- 9.6K to 115.2K bps and extension to 1M & 4M bps
- IrLAP, IrLMP, IrCOMM, IrLAN, etc
- Tightest assembly code on the market!
- Specialize in various micro-controller assembly codes and C codes
- Source code and object code for licensing
- Contract design and consulting services

1. IrDA Protocol Software for Peripheral Devices

- In 80C51 code (4K Byte memory space!). (IR920SW/9200SW)
- In C-code. (IR940SW/9400SW)
- Also ported to other micro-controller assembly codes.
- Already integrated into printer, cellular phone, pager, instrument, etc.

2. IrDA Protocol Software for Palmtop Computers

- In C-code for DOS or RISC devices. (IR960SW/9600SW)
- Already integrated into palmtop PC, notepad, etc.
- Can also be embedded into IrDA ASIC chips.
- Major Features
 1. A generic core implementation of the IrLAP, IrLMP and IrComm protocol software
 2. It can be ported to different micro-controllers
 3. Conforms and exceeds minimum requirements for IrLAP and IrLMP secondary and primary
 4. Supports multiple baud rates: 2.4k, 9.6K, 19.2K, 38.4K, 57.6K, 115.2K, 1M, 4Mbps
 5. Supports 64, 128, 256, 512, 1024, 2048 and 4096 byte frame sizes if 128, 256, 512, 1024, 2048, 4096 and 8192 bytes of SRAM, respectively, are used
 6. Requires only 4K bytes of on-chip ROM of typical 8-bit micro-controller
 7. Co-exists with ASK-IR protocol to become Dual-Mode SIR Protocol set
- Major Software Components
 1. High level I/O driver -- receive a frame, send a frame, etc
 2. Buffer management
 3. State machine -- discovery, connection, etc
 4. Initialization -- code start, warm start, etc
 5. Main program -- printer application
 6. Low level I/O driver, etc

ACTiSYS IrDA-FIR Testing Software IR9000SW Set-up Instruction

IR9000SW is the IrDA-1.1 compatible hardware system test software for two-stations set up. It is used in conjunction with the ACTiSYS IrDA fast infrared add-on card ACT-IR2000B and motherboard adapter ACT-IR2000L as reference unit for testing both IrDA notebook or desktop PC as DUT (Device Under Test). Another IR2000L is used as attachment to the motherboard of the DUT desktop PC. It is being used as IrDA test reference for engineering and production-line test stations at the leading IrDA notebook and motherboard and desktop PC manufacturers.

1. System Requirement:

- IBM compatible 80x86, Pentium PC system with ACTiSYS IrDA-FIR add-on card ACT-IR2000B and FIR motherboard adapter ACT-IR2000L as the reference system.
- Another ACT-IR2000L is used for the FIR super I/O equipped motherboard of DUT desktop system, or notebook with built in IrDA-1.1 FIR window.
- MS-DOS or Windows 95/MS-DOS mode.

2. Hardware Set Up:

- Plug the ACTiSYS IR2000B add on card into one free ISA slot on the motherboard of the reference system and connect the ACT-IR2000L FIR adapter to this add on card.
- If test the IrDA window built into notebook, go to the next step. If test the IrDA-FIR function of a desktop PC, plug another ACTiSYS IR2000L on the FIR motherboard of the DUT desktop PC.
- Aim two infrared ports at each other.

3. Software Set Up:

- The default setting is:
 - FIR Add-on Card: IR2000B
 - FIR M.B. Adapter: IR2000L
 - COM Port: 2
 - IRQ: 3
 - Data Transfer Method: DMA
 - Tx/Rx DMA Channel: 0
 - FIFO Level: 32Bytes
 - Start Up Level: Master
 - Test Speed: FIR (4Mbps)
 - No. of Packets: 20
 - Packet Size: 2048
 - Packet Pattern: #4
 - Error Rate(%): 0.00
 - Error Rate Factor: 1.00
 - Direction: Two Ways
 - Beeper: Off
- Type *IR9k* set will activate interactive setting which allows you to select different setting parameters.
 - COM Port: Com 1 to Com 4.
 - IRQ: 3 to 5, 7, 9, 11, 15.
 - Data Transfer Method: DMA or PIO.
 - Tx/Rx DMA Channel: 0, 1, 3.
 - FIFO Level: 16Bytes or 32Bytes.
 - Start Up Mode: Master or Slave.
 - If Master is selected:
 - Speed Choice: FIR (4Mbps) or MIR (1Mbps).
 - Packet Number: Any, up to 32,000 packets.
 - Test Packet Size: 512, 1K, 2K, 4K, 8K Bytes per packet.
 - Test Pattern: #1, #2, #3, #4.
 - #1-Special pattern, #2-Sending all 0's,
 - #3-Sending all 1's, #4-Sending random numbers
 - Passed Error Rate: Any.
 - Error Rate: Any; % or BER (Bit Error Rate).
 - Direction Choice: One way or two ways.
 - Beeper: On or Off.
- A file *DEFAULT.9k* can be used to save the setting parameter as default setting.
- A file *Result.9k* can be used to save all the [test results](#).

IrDA-1.1 (FIR) PROTOCOL, SYSTEM INTEGRATION AND TESTING

By Dr. Keming W. Yeh and Dr. Lichen Wang

ABSTRACT In 1996, IrDA-1.0

(SIR, 115.2K bps) standards were widely adopted after only two-and-half years of the formation of IrDA Association. A short one year later, we see the full range of products for IrDA-1.1 (FIR, 4M bps) standards appearing; components, adapters, software and mobile devices. The faster transfer rate (4M bps) and more complex bus interfaces make the FIR controller and system implementation more difficult. The integration of the IrDA-1.1 protocol stack into embedded-controller devices is also more complex and sensitive than IrDA-1.0. Additionally, the IrDA-1.1 feature designed into these devices may not easily meet the error rate and distance specifications. Effective and comprehensive testing software is needed for debugging and production testing.

IrDA STANDARDS

The Infra-Red Data Association (IrDA) was founded in 1993 to promote an industrial standard for Infra-red communications.

Currently, IrDA standard consists of three mandatory and many optional components. The three mandatory components are: Physical Layer, IrLAP Layer, and IrLMP Layer. The optional components are: TinyTP, IrCOMM, and many more.

PHYSICAL LAYER

The IrDA Physical Layer Specification sets a standard for the IR transceiver, the modulation or encoding and decoding method, as well as other physical parameters.

IrDA uses IR with peak wavelength of 0.85 to 0.90 μ m. The transmitter's minimum and maximum intensity are 40 and 500 mW/Sr within a 30 degree cone. The receiver's minimum and maximum sensitivity is 4 μ W/ (cm.cm) and 500 mW/(cm.cm) within a similar 30 degree cone. The link length is 0 m to 1 m.

There are three different modulation or encoding/decoding methods. The first one is mandatory, whereas the other two are optional.

For transfer rate of 9.6, 19.2, 38.4, 57.6 or 115.2 kbps operations, a start (0) bit and a stop (1) bit is added before and after each byte of data. This is the same format as used in a traditional UART. However, instead of NRZ, a method similar to RZ is used, where a (0) is encoded as a single pulse of 1.6 μ sec to 3/16 of a bit cell, and a (1) is encoded as the absence of such a pulse. In order to have unique byte patterns to mark beginning and ending of a frame and yet allow any binary data bytes, byte stuffing (escape sequence) is used in the body of the frame. A 16-bit CRC is used for error detection. This asynchronous modulation method is sometimes referred to as SIR. The 9.6 kbps SIR operation is mandatory. Before any other optional data rates are used, the mandatory 9.6 kbps SIR must be used first to negotiate those options.

For transfer rate of 0.576 or 1.152 Mbps, no start or stop bits are used and the same synchronous format as HDLC is used. Again, a (0) is encoded as a single pulse (1/4 the bit cell) whereas a (1) is encoded as the absence of such a pulse. In order to ensure clock recovery, bit stuffing is used (same as in HDLC). The same 16-bit CRC is also used. This modulation method is sometimes referred to as MIR. MIR operation is optional, but before this option is used, the mandatory 9.6 kbps SIR must be used first to negotiate this option.

For transfer rate of 4.0 Mbps, a 4-PPM method is used. Like MIR, no start or stop bits are used. In addition, bit and byte stuffing are not needed either. A 32-bit CRC is used in this case. This modulation method is sometimes referred to as FIR. FIR operation is optional, but before this option is used, the mandatory 9.6 kbps SIR must be used first to negotiate this option.

Details of the physical layer are specified in IrDA publication: "Serial Infrared Physical Layer Link Specification". Current version is Version 1.1 dated Oct 17, 1995.

IrLAP LAYER

The IrDA Link Access Protocol (IrLAP) establishes the IR media access rules and various procedures for discovery, negotiation, information exchange, etc. IrLAP is a mandatory layer of the IrDA standard but not all the features are mandatory.

The main media access rules are that for any station which is currently not participating in a connection, it must listen for more than 500 msec to make sure that there is no IR traffic before it starts to transmit, and that for any station which is currently participating in a connection, it must transmit a frame within any given 500 msec.

Media access among the stations participating in a connection is controlled by a token-like Poll/Final bit in each frame.

Transmission of user data without first establishing a connection is allowed in IrLAP. 9.6 kbps SIR must be used for this kind of connection-less communication. As far as IrLAP is concerned, connection-less transmissions are broadcast in nature and are not acknowledged and not reliable.

The discovery procedure defines an orderly way to exchange IDs. 9.6 kbps SIR must be used for discovery. The initiator broadcasts its own ID repeatedly for a known number of times and listens between these repeated transmissions (slots). The responders randomly choose one of the slots and send their own IDs. If there is a collision, this procedure can be repeated.

The negotiation procedure is used to establish a connection with operating parameters that both parties can support. Some of these parameters, such as bit rate, must be identical for both sides, thus the "largest common denominator" is used. Some other parameters, such as maximum data size, are the limits of one party which the other party must respect. Like discovery, 9.6 kbps SIR must be used for negotiation.

The ability to respond to discovery and negotiation procedures is mandatory whereas the ability to initiate these procedures is optional. Stations that can respond but not initiate them are called Secondary Stations whereas Primary Stations are those that can both initiate and respond.

After all these operating parameters are known to both parties, a connection can be established. Before this happens, all traffic (connection-less transmission of data, discovery procedure, negotiation procedure, etc.) are carried out at 9.6 kbps SIR with maximum data size 64. Once connection is made, the negotiated data rate can be as high as 4 Mbps, the negotiated maximum data size can be as high as 2048 bytes.

During connection, the information exchange procedures are used. Frames containing user data are sequentially checked in addition to CRC. There are also supervisory frames used for flow control, error recovery, and to pass the token.

Due to the fact that a Secondary Station cannot initiate discovery and negotiation procedures, a Secondary Station cannot make a connection to another Secondary Station.

A Primary Station can connect to a Secondary. It can connect to another Primary too. In such a case, only one of the Primary Station in the connection may play the Primary Role. The other Primary Station will play the role of a secondary.

The station playing the Primary Role is responsible for the recovery of lost token, to maintain the 500 msec heart beat, and, in general, the orderly operation of the connection. Data exchange is always bi-directional, and independent on whether the station is primary or secondary.

ther procedures, for example: sniffing, address conflict resolution, exchange primary/secondary roles, just to name a few. Collectively, IrLAP provides an orderly and reliable connection between the IR stations.

Details of the IrLAP Layer are specified in IrDA publication: "Serial Infrared Access Protocol (IrLAP)" Current version is Version 1.1 dated June 16, 1996.

IrLMP LAYER

The IrDA Link Management Protocol (IrLMP) consists of two components: the Link Management Information Access Service (LM-IAS), and the Link Management Multiplexer (LM-MUX). IrLMP is a mandatory element of the IrDA standard, but again, not all features of IrLMP are mandatory.

LM-IAS entity maintains an information base so that other IrDA stations can inquire what services are offered. This information is held in a number of objects, each associated with a set of attributes. For example, "Device" is a mandatory object and has attributes "DeviceName" (an ASCII string) and "IrLMPsupport" (IrLMP version number, IAS support, and LM-MUX support).

The other component of IrLMP, LM-MUX, provides multiple data link connections over the single connection provided by IrLAP. Within each IR station, multiple Link Service Access Points (LSAPs) can be defined, each with a unique selector (LSAP-SEL). LM-MUX provides data transfer services between LSAP-SEL end points within the same IR station as well as across the IrLAP connection to other IR stations. The LM-IAS discussed previously uses a pre-defined LSAP-SEL (0) for other IR stations to access over IrLAP and through

LM-MUX

The LM-MUX can be in one of two modes, exclusive or multiplexed. When in exclusive mode, only one LSAP connection may be active. In this case the flow control provided by IrLAP can be used for the only connection. When in multiplexed mode, several LSAP connections may actively share the same underlying IrLAP connection. However, in this case additional flow control must be provided by upper layers or the applications.

Details of the IrLMP Layer are specified in IrDA publication: "Link Management Protocol (IrLMP)" Current version is Version 1.1 dated Jan 23, 1996.

TinyTP, IrCOMM, AND BEYOND

TinyTP is an optional transport protocol. The main purposes are to provide individual LSAP flow control functions and to segment or reassemble data. The additional flow control is needed when the LM-MUX is in multiplexed mode. The segmentation and reassembly of data is used to match the user buffer size and IrLAP/IrLMP data size.

Details of the TinyTP Layer are specified in IrDA publication: "Tiny TP: A Flow Control Mechanism for use with IrLMP" Current version is Version 1.1, Jan 3, 1997.

IrCOMM is a protocol to emulate pre-existing wired serial and parallel ports. There are four service types. The 3-wire raw service type emulates a 3-wire RS-232 port (with TxD, RxD and Gnd wires with no flow control). It has no control channel and relies on IrLAP for flow control (and hence it must use LM-MUX exclusive mode). The other three service types use TinyTP and have separate control channels. They emulate 3-wire (cooked), 9-wire, and Centronics parallel.

Details of the IrCOMM are specified in IrDA publication: "IrCOMM: Serial and Parallel Port Emulation over IR" Current version is Version 1.0 dated Nov 7, 1995.

Other IrDA optional layers include OBEX (Object exchange), and many others. Most of these optional layer are aiming at facilitating the adoption/development of application programs.

Physical Layer, IrLAP, and IrLMP are the only layers that are mandatory in the IrDA standard. While these three layers provide the bases for an efficient and reliable link, the design is extensible and open-ended. IrDA has defined and is continuously working on other options.

The www.irda.org web-site provides information about the organization, its members, the standards, etc. It also has a resource list about IR components, systems, hardware & software licensing or consulting services provided by its members.

IMPLEMENTATION ISSUES

IrDA standards are aimed at a very broad spectrum of applications. It has a minimal set of mandatory requirements and a wealthy array of options. In practice, there is no device that only implements the minimum requirement. There is also no system that has implemented all the IrDA optional features either. The first step in implementation is to decide what optional features to include. The first two decisions to make are data rate and Primary vs. Secondary.

Data rate obviously has a profound effect on performance. For SIR, or data rate of 9.6 up to 115.2 kbps, the hardware usually consists of an UART, a SIR encoder/decoder, and an IR-transceiver. For MIR and FIR however, a serial communication controller (SCC) chip specifically designed for IrDA must be used and a faster IR-transceiver is needed.

Furthermore, when MIR or FIR is used, SIR is still needed as mandated by IrDA protocol.

The Primary vs. Secondary decision has nothing to do with direction of data flow. Both Primary and Secondary may and must support bi-directional data transfer. The most prevailing difference between the two is that a Secondary Station cannot make IR connection with another Secondary Station, whereas a Primary Station can make IR connection with either Secondary or Primary Stations. The technical limitation that a Secondary Station cannot "initiate" discovery, negotiation, and connection procedures is often obscured by the application program and user

interface. In certain applications, the user must activate both the Primary Station and the Secondary Station, the order of activation does not matter. In some other application, the user only needs to activate one of them, often but not necessarily the Primary.

Some examples of the SIR protocol stacks are the ACT1-Plus for primary station and ACT2-Plus for secondary station; and ACT11-Plus and ACT12-Plus for MIR/FIR respectively from ACTiSYS Corp. These core protocol stacks are usually tailored for the various OEMs to meet their memory, system software interface and CPU speed requirements of their target systems as well as the application models and environments.

IrDA LITE

Aside from data rate and Primary vs. Secondary, there are many other optional features to be considered. For any given application, "more" is not necessarily "better". Here are a few examples:

The main feature of LM-MUX is to provide multiple data link connections over the single connection provided by IrLAP. But for some applications, you have to add the "exclusive mode" feature to restrict LM-MUX so that the "multiple data link" is limited to one data link. For these applications, it is better not to have the "multiple data link" capability to begin with, rather than implementing it and use "exclusive mode" to defeat it. Usually, multiple data link over a single connection provided by IrLAP is not very useful unless both ends of the IrLAP connection are capable of multitasking. Even then, it is questionable. For example, to transfer two files at the same time each at less than one half the speed is not necessarily better than transferring them one at a time at full speed.

The multiple window size is another example. When the data rate is 57.6 kbps or less, multiple window size is not useful at all. It may contribute to effective data rate performance only at higher raw data rate. Even then, if the application is interactive or transaction oriented, multiple window size may actually slow down the turnaround time and make the link sluggish.

IrDA publication: "Minimal IrDA Protocol Implementation (IrDA Lite)" provides suggestions of strategies that can substantially simplify the implementation of IrDA standards -- whether it is minimal or not. The current version for "IrDA Lite" is Version 1.1 dated Nov 7, 1996.

Examples of the IrDA Lite protocol stacks are the ACT1-Lite and ACT2-Lite from ACTiSYS Corp. The C code sizes are in the range of 10~15 Kbytes and 3~6 Kbytes for ACT1-Lite and ACT2-Lite respectively.

SYSTEM DESIGN AND INTEGRATION

To implement IrDA standards for up to 115.2 kbps data rate, an UART, a SIR encoder/decoder, and an IR-transceiver are needed. The UART is often part of the on-chip peripherals. Obviously, the UART must be able to handle the mandatory data rate of 9.6 kbps and all the optional data rates intended. In addition, the CPU must be able to handle the UART at those data rates without causing latency problems for both the UART and other peripherals in the system.

Unlike other simpler serial I/O protocols, IrDA protocols also need a timer and a multi-thread operation environment. This is particularly true for the Primary Station which must initiate the discovery procedure and also keep the 500 msec heart beat during connection. Even when the application program is not actively using the IrLAP link for input or output, the IrDA driver must exchange supervisory frames. This cannot be easily accomplished if the IrDA driver can get control of the CPU only when the application program calls it or when an UART interrupts.

It is preferred that UART interrupts be handled at a fairly high priority to avoid UART data overrun error. However, when a complete packet (called a "frame" in IrDA standards) is received, a much lower priority can be used to execute the bulk of the IrDA protocol. Doing so will prevent the lengthy IrDA protocol from blocking other latency sensitive hardware interrupts. Relying on the hardware to change the UART interrupt priority in the middle of the interrupt service routine often cannot produce the desired effect and can cause interrupt priority inversion.

To implement MIR and FIR, a SCC chip specifically designed for IrDA standards and a faster IR-transceiver must be used. In principle, once such a controller is used, the rest is easy. In practice, this is often not the case!

The UART is a standard fixture for PCs as well as many microcontroller based systems whereas the special SCC chip is not. I/O addresses, interrupt vectors, and DMA channels all have to be allocated without generating conflict with other standard and pre-existing peripherals. This is particularly difficult with the vastly popular and diverse "IBM compatible" PCs. Early last year, the IR team at Microsoft sent messages to all IrDA members and urged them not to

use interrupt or DMA. It is not clear whether this is practical, but so far all the hardware implementations for MIR and FIR on PC's are still using interrupts and DMAs.

For systems other than IBM compatibles, implementing MIR and FIR is not any easier. Most, if not all, IrDA specific SCC chips currently available are designed with IBM compatibles in mind. Technical data about hardware interface and DMA are often incomplete, inaccurate, and replaced by slogans such as: "Windows-95 compatible". Furthermore, these SCC chips often include the UART function for SIR. If the SIR support is already implemented with the micro-controller's on-chip UART, that portions of the code must be re-written to utilize the different UART on the SCC chip!

IrDA-1.1 HARDWARE SYSTEM TEST SOFTWARE

The design of IrDA-1.1 hardware system and the integration of the IrDA-1.1 protocol stack is much more complex than IrDA-1.0. An engineering debug tool which can also be used for efficient and accurate production-line testing is very desirable! An example of IrDA-1.1 system test software is the ACT-IR9000SW from ACTISYS Corp.

The design goal of IR9000SW test software is to provide the engineers in hardware design, testing and production a tool that can: 1) support various brands of infrared transceiver modules and digital super I/O controller chips, 2) test quickly the infrared communication error rate with different data transfer patterns and packet sizes under various speeds, 3) verify the functionality of IrDA-enabled hardware systems and also be used as the efficient production-line test tool.

IR9000SW is designed to run on one DUT (Device Under Test, e.g. FIR equipped notebook PC) system and test against a FIR reference system. The program is structured to support mixed hardware configurations. It has two working modes: master and slave. In the master mode, it will try to discover another system running in slave mode at certain speed. In the slave mode, it will scan through different speeds trying to pick up a call from the master.

IR9000SW uses its own IrDA-like protocol instead of using directly the IrDA protocol. This is to quickly focus on testing the performance, reliability and problem of the hardware system, without the complication, delay time and restart problem of the IrDA protocol stack.

In operation, the reference system is configured to be the master. It will loop indefinitely trying to find a slave station or receive a command to quit. The DUT system is the slave. Once master station discovers the slave, it will download the testing parameters to the DUT and start the loop test. The test results are dynamically displayed while testing is in progress.

This includes error rates in the transmission or receiving mode, % of file transferred and received for different speeds, at a fixed distance and half angle.

IR9000SW also has a set-up module to set the testing parameters, sequence and hardware configuration. It can record these new parameter settings into a configuration file for current testing session, or into a default setting file for future continuous use.

Setup parameters include the following:

COM Port: Com 1 to Com 4.

IRQ: 3 to 5, 7, 9, 11, 15.

Data Transfer Method: DMA or PIO.

Tx/Rx DMA Channel: 0, 1, 3.

FIFO Level: 16Bytes or 32Bytes.

Start Up Mode: Master or Slave.

If Master is selected: Speed Choice: FIR or MIR

Packet Number: Any, up to 32,000 packets.

Packet Size: 512, 1K, 2K, 4K, 8K bytes per packet

Test Pattern: #1, #2, #3, #4.

#1 = Special pattern

#2 = Sending all 0's

#3 = Sending all 1's

#4 = Sending random numbers

Pass/Fail Error Rate: Any Error Rate: % or BER (bit error rate).

Direction: One way or Two ways.

Beeper: On or Off.

- FIR controller vendor: NS, SMC, Winbond Model # & Base Address: Auto Detection
- DEFAULT.9k file can automatically save the setting parameter as default setting.
- RESULT.9k file can automatically save all the test results and time stamp them.

CONCLUSION

We have described here the IrDA-1.0 and 1.1 physical and protocol specifications, the implementation issues, system integration issues and FIR system test software tool.

In 1996, the issue was the adoption rate of SIR standards in notebook PCs. Now, the SIR has been built into most notebook PCs and also into cellular phone, digital camera, pager, medical device, industrial data terminal and printer, pay phone and others.

1997 will see SIR volume growth, FIR adoption and emerging killer applications. Future new standards include: USB-IrDA, Long-distance Control IR, Mobile Comm. Digital Camera and Faster IrDA.

IrDA PROTOCOL INTEGRATION AND SYSTEM TESTING

Dr. Keming W. Yeh and Dr. Lichen Wang

ABSTRACT IrDA Physical and Protocol Standards have been published since 1994 and there have been more than 20 million units of IrDA enabled products on the market. The component and system infrastructures are in place and complete. These include hardware components, protocol stacks and IrDA-equipped notebook PC, motherboards and O.S. like Windows 95, DOS and real-time O.S. These encourage more new IrDA-enabled embedded devices. However, there are many issues to be considered when implementing Protocol Stacks and testing these completed IrDA portable devices. This paper will discuss these issues by various device examples.

BACKGROUND The IrDA stack has three mandatory protocol layers, Physical layer, Infrared Link Access Protocol (IrLAP) and Infrared Link Management Protocol (IrLMP). On top of these, there are many optional layers. Tiny Transport (TinyTP) is one of them and is often needed to support other upper layers such as IrCOMM, IrLAN, IrTranP, or Obex, just to name a few.

PHYSICAL LAYER

The Physical layer consists of an IR transceiver, an encoder/decoder, a serializer/deserializer and a framer. The IR transceiver converts electrical signals to and from IR signals. The serializer/deserializer converts the serial bits to and from bytes. The framer assembles and disassembles IrDA frames by adding or removing the frame wrapper to or from the payload and generates or checks the CRC error checking.

IrDA compliant IR transceivers are available from many component manufacturers. They fall into two categories, the FIR or IrDA-1.1 transceivers, and the SIR or IrDA-1.0 transceivers. The former can handle data rates of up to 4 Mbps, while the latter can only handle data rates of 115.2 kbps or below.

For data rates of 115.2 kbps or below of IrDA-1.0, encoder/decoders are available from many component manufacturers. Most of these encoder/decoders are designed to interface directly to traditional UART that performs the serialization/deserialization functions. In most cases, the framer function must be handled by software.

For the higher data rates of IrDA-1.1, the encoder/decoder, the serializer/deserializer, and the framer are often integrated into the same digital chip. Most of these chips need DMA support in the system.

When the framer function is handled by software, it must satisfy the latency requirement of the UART. To handle the framer receive function, it can be quite demanding on the CPU. A FIFO in the UART receiver can alleviate the problem at peak demand, but it does not help the average demand.

Note that all IrDA stacks must support 9.6 kbps data rate. It is ironic that the software support for lower data rate is often more complex and more demanding in CPU performance than that of higher data rate. This is the usual result of hardware software tradeoff.

PROTOCOL LAYERS

IrLAP, IrLMP as well as optional upper protocol layers are almost always implemented in software. They can be integrated into a monolithic unit for the sake of code size and execution efficiency. Or, they can be modular and clearly separated from each other for the sake of clarity, portability and ease of maintenance.

Simple I/O devices need CPU services only when called by application programs or when external events interrupt. But in addition to those, IrDA software layers need CPU services to perform error recovery, to maintain the integrity of the IR link, and to enforce or comply with the media access rules.

Most IrDA software layers are defined in terms of multiple concurrent event driven finite state machines. The events that drive these state machines include application program requests, framer input/output interrupts, timer expirations, as well as actions of other state machines. Consequently, a multi-task or multi-thread environment is most convenient for implementing these software layers. In the absence of such an environment, a programmable hardware timer with a fairly low interrupt priority can be used to thread the state machines. The reason that this interrupt priority to be low is to avoid generating latency problems for other hardware interrupt service routines which may be time critical.

From the protocol point of view, IrLAP, IrLMP and most upper layers are not very time critical. Latency of up to tens of milliseconds can be tolerated and still compliant with IrDA standards. However, effective data rate will suffer, especially at high raw data rate. At 115.2 kbps, it takes 177 milliseconds to transmit a 2 KB frame. A 10 milliseconds delay will degrade the effective data rate by 6 percent. At 4 Mbps, it takes 4 milliseconds to transmit a 2 KB frame. The same 10 milliseconds delay will degrade the effective data rate by 250 percent.

Infrared Link Access Protocol (IrLAP)

While IrLAP layer is mandatory, not all features defined in IrLAP are. For example, the ability to respond to Discovery and play the role of a Secondary during Connection are both mandatory, but the ability to initiate Discovery and play the role of a Primary during Connection are not. IrDA devices that implement only the former are referred as Secondary Stations while devices that implement both features are called Primary Stations. Note that a Primary Station may and must be able to play the Secondary role. A Secondary Station is much simpler to implement, but it cannot communicate to peers or other Secondary Stations such as IrDA enabled printers, modems etc.

There are many other optional IrLAP features that may or may not be implemented. Usually, this is determined by the intended application of the device, or, to a lesser degree, the limitation of the hardware involved.

Optional IrLAP features often not implemented are the point to multi-point connection, the primary/secondary role exchange, and the sniff open procedure. It is unclear whether this is due to the lack of necessity or the lack of diligence.

Note that all optional features can be used only if both parties in the connection (or intended connection) support them.

Infrared Link Management Protocol (IrLMP)

Like IrLAP, IrLMP also has many optional features that are not mandatory. Their implementation are thus mandated by the intended application.

One of the optional IrLMP feature is the multiplex mode which provides multiple logical data link connections over the single physical IrLAP link. This feature may be useful if the application programs in one device needs to access multiple resources in the same device at the other end of the IrLAP connection simultaneously.

The IrLMP multiplex mode feature is not to be confused with the point to multi-point feature of IrLAP. The scenario that a user with a handheld IrDA device can access information from several IrDA kiosk at the same time, or that many users with handheld IrDA device can access information from the same IrDA kiosk simultaneously can be achieved with point to multi-point IrLAP, but not with IrLMP multiplex mode.

Currently there are very few applications that can take advantage of the IrLMP multiplex mode. If the multiplex mode is implemented, another optional feature, namely exclusive mode, is often necessary. The exclusive mode nullifies the effect of multiplex mode so that a single logical connection can exclusively own the physical IrLAP connection.

The Information Access Service (IAS), at least a subset of it, is a mandatory IrLMP feature. The information it provides must reflect the optional features that are being supported by the various software layers.

Tiny Transport (TinyTP) and other Upper Layers

TinyTP is not a mandatory layer in IrDA Standards, but it is often necessary since most other upper layers require it.

TinyTP has two major functions, flow control and segmentation/desegmentation. The TinyTP flow control for individual logical data link on top of the common IrLAP flow control is used to handle the possible presence of IrLMP multiple mode. The segmentation/desegmentation is used to match the data size of the upper layers (or the application) with the negotiated IrLAP frame size. Some of the upper layers do not really need these two features of TinyTP, but they do require it.

IrDA STACKS AND APPLICATIONS

As stated in the previous section, many optional features in the IrDA stack are mandated by the application intended. Here are a few real life examples.

Digital Camera

IrTran-P is the standard upper layer for digital camera. IrTran-P in turn requires IrCOMM, and TinyTP to be included. At IrLMP layer, multiplex mode is not needed. At IrLAP layer, Primary capability is needed due to the desire to be able to transfer digital pictures to peers and printers. The optional high speed data rate is desirable.

Medical Monitoring Device

Small amounts of data/program need to be up/down-loaded to/from PC's. IrCOMM 3 wire raw is sufficient. Thus TinyTP and IrLMP multiplex mode are not needed. At IrLAP layer, Secondary capability is sufficient.

Industrial Portable Data Terminal

Just like the medical device, small amounts of data/program need up/down-loaded to/from PC's. IrCOMM 3 wire raw is sufficient. Thus TinyTP and IrLMP multiplex mode are not needed. At IrLAP layer, Secondary capability is sufficient. In some cases, the modem status and control lines need to be supported. Instead of IrCOMM 3 wire raw, the 9 wire cooked feature needs to be used. In this case, TinyTP is required too. IrLMP multiplex mode is not needed.

**Printers**

IrLPT is the de facto standard for printers. TinyTP and IrLMP multiplex mode are not needed. At IrLAP layer, IrCOMM 3 wire raw can be used to substitute IrLPT. Alternatively, IrCOMM 3 wire or 9 wire cooked, or parallel port can also be used. In the latter case, TinyTP is required but IrLMP multiplex mode is still not needed. If the printer is intended to print pictures from digital cameras, IrTran-P, IrCOMM, and TinyTP are required. IrLMP multiplex mode and Primary capability are still not required.

General IrDA-to-RS232 Docking Station

IrCOMM 9 wire is sufficient. TinyTP is required but IrLMP multiplex mode is not. At IrLAP layer, Secondary capability is sufficient.

Cell Phone or Smart Phone

IrTelecom is the standard upper layer. Obex is desirable. TinyTP is required but IrLMP multiplex mode is not. At IrLAP layer, Secondary capability is sufficient unless printing capability is also wanted.

Pager

Obex is sufficient. TinyTP is required but IrLMP multiplex mode is not. At IrLAP layer, Secondary capability is sufficient unless printing capability is also wanted.

IR Modem

IrCOMM 9 wire is sufficient. TinyTP is required but IrLMP multiplex mode is not. At IrLAP layer, Secondary capability is sufficient.

PDA

Most likely, Windows-CE is the operating system. Thus the IrDA Stack for Windows-CE should be ported to the target system.

Power Monitoring Meter

IrCOMM 3 wire raw is sufficient. Thus TinyTP and IrLMP multiplex mode are not needed. At IrLAP layer, Secondary capability is sufficient.

Portable Storage Devices

This device is meant to be a server for PDA's, Digital Cameras, etc. As such, it needs to support all the upper layers that the client requires, such as Obex, IrTran-P, IrCOMM, etc. IrLMP multiplex mode is nice to have, but probably of no real use. The exclusive mode must be included to nullify multiplexing if multiplex mode is included. The client is usually a Primary and the server a Secondary, but if printing service is desired, this server also need Primary capability. High data rate is often desirable.

IrDA SYSTEM TESTING

Most of the hardware components such as the IR transceiver, the encoder/decoder or the integrated IrDA I/O chip are often tested by the component manufacturer to be IrDA compliant. Each software layer of course can also be individually tested to be IrDA compliant. However, when all these IrDA compliant components are put together, unexpected result may happen.

Once the engineering phase is done and manufacturing phase starts, there are many possibilities at the assembly line too.

Methods for system testing must be planned and designed into the implementation, not an afterthought. A good system test methodology is essential to facilitate both engineering and the production.

Most of engineering mishaps usually are in the area between the Physical Layer and IrLAP. Production mishaps usually are confined to Physical Layer only. Consequently, a very simple and effective system test is to access the optional test frame feature of IrLAP, particularly the test frame feature within a connection.

The test frame feature is very simple to implement in the device under test. This can usually be accomplished by only 10 lines of C codes! If implemented, a specially programmed tester can fully exercise the Physical Layer and IrLAP layer in the device under test automatically. This test can range from very thorough for engineering study to very speedy for production and quality control. Tester programs and devices are available commercially.

CONCLUSION

The IrDA implementation of the published Standards have progressed from the stabilization of device driver and better price of FIR hardware components in 1997, to the easier implementation and ready availability of SIR/FIR protocol stacks in 1997/1998, to the issues of inter-operability, testability and field service testing tools to be addressed in 1998/1999. There still remain the issue of easy-to-use application programs. The addition of next generation IrDA Protocol Standards of CIR, AIR will expand the IrDA application space but will face far more challenge. They will benefit from the experience and methodology established during the IrDA-1.0 and IrDA-1.1 implementation effort.

An Introduction To The IrDA Standard And System Implementation

Feature article of *Wireless Systems Design*, May 1996
By Dr. Keming W. Yeh and Dr. Lichen Wang

Abstract



The [IrDA standard](#) has successfully progressed from IrDA-1.0 (115.2Kbps) to IrDA-1.1 (4Mbps) in the short two and half years. There are many components, adapters, software and mobile systems available for the IrDA-1.0 standard on the market now. The same will happen soon for IrDA-1.1 standard with the optoelectronic, analog and digital interface ASIC components already on the market. It is important to understand the difference between IrDA-1.0 and IrDA-1.1 in the physical modulation, protocol, system implementation and external attachment considerations.

Introduction

[Infra-red Data Association \(IrDA\)](#) Infra-red has long been used as a transmission medium for TV/VCR controllers, calculators, printers, and PDAs. In late 1993 an industrial group spearheaded by HP, IBM, and Sharp was founded to promote an industrial standard for Infra-red communications. A short two and half years later, this group, the Infra-red Data Association, has grown to 130 members strong. The membership are international and include component manufacturers, OEMs, hardware and software companies. More impressively, by 1995, many IrDA compliant products are already in the end users' hands. This includes IR equipped notebook PCs, PDAs, printers, as well as IR adapters for PCs, printers, etc. According to BIS Strategic Research, by 1996, 85% of the new notebook PCs will have IrDA capability built into the systems. Unlike the earlier IR predecessors which use proprietary protocols, this new crop of IrDA compliant equipments are inter-operative across applications, across manufacturers, and across platforms. The key features of IrDA standard are:

- Simple and low cost implementation
- Low power requirement
- Directed, point-to-point connectivity
- Efficient and reliable data transfer

Physical Layer

The IrDA Physical Layer Specification sets a standard for the IR transceiver, the modulation or encoding/ decoding method, as well as other physical parameters. IrDA uses IR with peak wavelength of 0.85 to 0.90 micro-meter. The transmitter's minimum and maximum intensity is 40 and 500 mW/Sr



within a 30 degree cone. The receiver's minimum and maximum sensitivity is 0.0040 and 500 mW/(cm.cm) within a similar 30 degree cone. The link length is 0 to 1 m with an error rate of less than 1 in 10⁸ bits. There are three different modulation or encoding/decoding methods. The first one is mandatory for both IrDA-1.0 and IrDA- 1.1. The other two are optional and are for IrDA-1.1 only. For transfer rate of 9.6k, 19.2k, 38.4k, 57.6k or 115.2 kbps operations, a start (0) bit and a stop (1) bit is added before and after each byte of data. This is the same format as used in a traditional UART. However, instead of NRZ, a method similar to RZ is used, where a 0 is

encoded as a single pulse of 1.6 micro-sec to 3/16 of a bit cell, and a 1 is encoded as the absence of such a pulse. In order to have unique byte patterns to mark beginning and ending of a frame and yet allow any binary data bytes, byte stuffing (escape sequence) is used in the body of the frame. A 16-bit CRC is used for error detection. The 9.6 kbps operation is mandatory for both IrDA-1.0 and IrDA-1.1. 19.2k, 38.4k, 57.6k and 115.2 kbps are all optional for IrDA-1.0 and IrDA-1.1. For transfer rate of 0.576M or 1.152 Mbps operation, no start or stop bits are used and the same synchronous format as HDLC is used. Again, a 0 is encoded as a single pulse (1/4 the bit cell) whereas a 1 is encoded as the absence of such a pulse. In order to ensure clock recovery, bit stuffing is used (same as in HDLC). The same 16-bit CRC is also used. Both 0.576M and 1.152 Mbps operations are optional for IrDA-1.1. For transfer rate of 4.0 Mbps operation, a 4-PPM method is used. Again, no start or stop bits are used. In addition, bit/byte stuffing are not needed either. A 32-bit CRC is used in this case. This rate is used in IrDA-1.1 only.

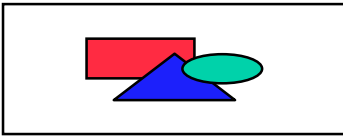
IrLAP Layer



The IrDA Link Access Protocol (IrLAP) establishes the IR media access rules and various procedures for discovery, negotiation, information exchange, etc. IrLAP is a mandatory layer of the IrDA standard but not all the features are mandatory. The minimum requirements are clearly spelled out in the

specification. The main media access rules are that for any station which is currently not participating in a connection, it must listen for more than 500 msec to make sure that there is no IR traffic before it starts to transmit, and that for any station which is currently participating in a connection, it must transmit a frame within any given 500 msec. Media access among the stations participating in a connection is controlled by a token-like Poll/Final bit in each frame. Transmission of user data without first establishing a connection is allowed in IrLAP. As far as IrLAP is concerned, connection-less transmission are broadcast in nature and are not acknowledged by the receiver. The discovery procedure defines an orderly way to exchange IDs. The initiator broadcasts its own ID repeatedly for a known number of times and listens between these repeated transmissions (slots). The responders randomly choose one of the slots and send their own IDs. If there is a collision, this procedure can be repeated. The negotiation procedure is used to establish a connection with operating parameters that both parties can support. Some of these parameters, such as bit rate, must be identical for both sides, thus the "largest common denominator" is used. Some other parameters, such as maximum data size, are the limits of one party which the other party must respect. After all these operating parameters are known to both parties, a connection can be established. Before this happens, all traffic (connection-less transmission of data, discovery procedure, negotiation procedure, etc.) are carried out at 9.6 kbps async. mode with maximum data size of 64 bytes. Once connection is made, the negotiated data rate can be as high as 115.2 kbps (IrDA-1.0) or 4 Mbps (IrDA-1.1), the negotiated maximum data size can be as big as 2048 bytes. During connection, the information exchange procedures are used. Frames containing user data are sequence checked in addition to CRC. There are also supervisory frames used for flow control, error recovery, and to pass the token. Connection may be one-to-one or one-to-many. One of the stations in a connection plays the role of a primary, all others play the roles of secondaries. Usually, the station that initiated the connection, or the common one in a one-to-many connection is the primary station. The primary station is responsible for the recovery of lost token, to maintain the 500 msec heart beat, and, in general, the orderly operation of the connection. In addition to the above major procedures, there are many other procedures, for example: sniffing, address conflict resolution, exchange primary/secondary roles, just to name a few. Collectively, IrLAP provides an orderly and reliable connection between the IR stations.

IrLMP Layer



The IrDA Link Management Protocol (IrLMP) consists of two components: the Link Management Information Access Service (LM- IAS), and the Link Management Multiplexer (LM- MUX). IrLMP is a mandatory element of the IrDA standard, but again, not all features of IrLMP are mandatory. LM-ISA entity maintains an information base so that other IrDA stations can inquire what services are offered. This information is held in a number of objects, each associated with a set of attributes. For example, "Device" is an mandatory object and has attributes "DeviceName" (an ASCII string) and "IrLMPSupport" (IrLMP version number, IAS support, and LM-MUX support). The other component of IrLMP, LM- MUX, provides multiple data link connections over the single connection provided by IrLAP. Within each IR station, multiple Link Service Access Points (LSAPs) can be defined, each with a unique selector (LSAP-SEL). LM-MUX provides data transfer services between LSAP-SEL end points within the same IR station as well as across the IrLAP connection to other IR stations. The LM-ISA previously uses a pre-defined LSAP-SEL (0) for other IR stations to access over IrLAP and through LM-MUX. The LM-MUX can be in one of two modes, exclusive or multiplexed. When in exclusive mode, only one LSAP connection may be active. In this case the flow control provided by IrLAP can be used for the only connection. When in multiplexed mode, several LSAP connections may actively share the same underlying IrLAP connection. However, in this case additional flow control must be provided by upper layers or the applications.

IrTP, TinyTP, IrCOMM, and Beyond



IrTP and TinyTP are optional transport protocols. The main purposes are to provide individual LSAP flow control functions and to segment or reassemble data. The additional flow control is needed when the LM-MUX is in multiplexed mode. The segmentation and reassembly of data is used to match the user buffer size and IrLAP/IrLMP data size. IrCOMM is the protocol to emulate pre-existing wired serial and parallel ports. There are four service types. The 3-wire raw service type emulates a 3-wire RS-232 port (TxD, RxD and Gnd wires with no flow control). It has no control channel and relies on IrLAP for flow control (and hence it must use LM-MUX exclusive mode). The other three service types use TinyTP and have separate control channels. They emulate 3-wire (cooked), 9-wire, and Centronics parallel. Other IrDA optional layers include PnP (Plug-and-Play), Obex (Object exchange), and many others. Most of these optional layers are aiming at facilitating the adoption/development of application programs. Physical Layer, IrLAP, and IrLMP are the only layers that are mandatory in the IrDA standard. While these three layers provide the bases for an efficient and reliable link, the design is extensible and open-ended. IrDA has defined and is continuously working on other optional upper layers.

IrDA-1.0 System Implementation



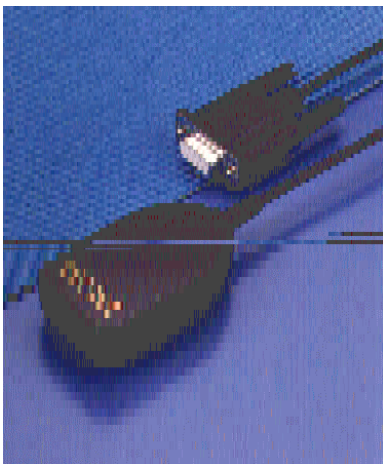
To implement IrDA capability into systems like notebook PCs, PDAs, etc., one needs to use the digital interface chip and an analog front-end component. IrDA-1.0 digital chips in the form of super I/O chips are provided by National Semiconductor, SMC, Winbond, etc. Analog modules are in two forms: chips or optoelectronic modules. Analog chips are supplied by Irvine Sensor, [Unitrode](#), Rohm and [Crystal Semiconductor](#) (which has an integrated mixed-signal analog/digital chip) where additional IR-LED and detector diode are needed and careful PCB layout around the sensitive detector circuitry is required. Optoelectronic modules are provided by [HP](#), [Temic](#), [Siemens](#), [Sharp](#), etc.

which integrate the analog chip with the IR-LED and diode in one compact module with various pinout configurations. The system implementation of IrDA- 1.0 is straightforward. The only inconvenience is the need to implement in IrDA application software (e.g. [Windows 95 -IR driver from Microsoft](#) or Tranxite file transfer software from Puma Technology) the respective hardware device driver to program speeds for each hardware systems. For IrDA-enabled portable devices that do not use Windows operating system, special IrDA protocol engine (stack) in either C or assembly codes need to be built in. Due to their limitation of low-power, slow CPU, limited memory, very compact IrDA protocol stack is required. [ACTiSYS](#) has successfully licensed their protocol stack in C or various assembly codes (model # [ACT- IR920SW-IR960SW](#)) to many OEM manufacturers of cellular phones, pagers, printers, portable instruments, portable storage devices, handheld PCs, etc. The code compactness is represented by one of their model, ACT-IR920SW (8031 code for peripherals) that is only 3.8 KBytes.

IrDA-1.1 System Implementation

Aside from the differences in the Physical Layer, The IrLAP, IrLMP, and upper layers of IrDA-1.0 and IrDA-1.1 are almost identical. By design, IrDA-1.1 is also backward compatible with IrDA-1.0. However, due to the much higher data rate allowed in IrDA-1.1, there are both hardware and software implications. For the 115.2 kbps top data rate used in IrDA-1.0, most computers and micro- controllers only need very minimum hardware and can use the CPU to handle the byte stuffing or removal and the CRC calculations. Low end micro-controllers such as 22 MHz 80C51 and 12 MHz Z80 has been successfully used to implement IrDA secondary stations at 115.2 kbps. The hardware needed consists of a UART (which most computers and micro-controllers may already have), a simple encoder/decoder circuit and the IR transceiver. For the 1.152M and 4.0 Mbps data rate used in IrDA-1.1, a packetizer must be used and the encoder/decoder circuit is more complex. The IR transceiver must also be capable of handling the faster speed. In most of the cases, DMA needs to be used to transfer data from the packetizer to and from memory. Even though there is no significant changes in the IrLAP, IrLMP, and upper layers of the protocol from IrDA-1.0 to IrDA-1.1, software efficiency must also be considered. For example, at 115.2 kbps, it takes about 100 msec to transmit a 1 KByte frame. Thus a 2 msec software overhead will only cause a 2 % degradation in performance. At 4 Mbps, however, it takes only 2 msec to transmit the same 1 KByte frame and the same 2 msec software overhead will cause a 100 % degradation in performance. In order to take advantage of the higher raw data rate, IrDA-1.1 software must be more efficient or be assisted by hardware.

External Connection



To implement IrDA-1.0 external adapters to be attached to the RS232 serial port, the challenge is to reach a long distance with reliable IR connection sustainable at 115.2Kbps baud rate, using only the limited current supplied from the RS232-port signal lines. This current is typically in the range of 10mA which needs to be booted up to around 21mA average current at 115.2Kbps rate in order to provide reliable IR communication at distance of 1 meter. ACTiSYS has successfully accomplished this with their [ACT-IR220L serial adapter](#) which offers 2.4 meter reliable IR link distance in most applications using no external power. For the Japanese market where ASK- IR modulation and protocol specification has long been used in consumer electronic devices like organizers, etc. It is very desirable to have both IrDA and ASK dual modes in the IR interface

device. One example is the ACTiSYS [ACT-IR200L dual-mode serial adapter](#). It also maintains the company tradition of long IR communication distance using only RS232-port signal power and no external power source. For implementing IrDA-1.0 external adapter for printer and other peripherals, compact IrDA protocol stack needs to be built into the adapter. Some examples are ACTiSYS's [ACT-IR100X and IR100M printer adapters](#). To implement IrDA-1.1 (1.152M and/or 4M bps) external serial adapter, RS232 port is too slow. There are four options: internal add-on card, special IrDA connector, enhanced parallel port, special serial port like Universal Serial Bus (USB), etc. All these options are being explored by many of the current IrDA adapter suppliers. Example is ACTiSYS's [ACT-IR2000 series](#). To implement IrDA-1.1 external adapters for printers, peripheral devices or wired LAN, the appropriate IrDA protocol stacks need to be built into the adapters. Examples are the LAN adapter from Extended Systems and ACTiSYS (ACT-IR1000M and IR6000N).

System Hardware Testing

The common problem faced by many of the IrDA-enabled systems manufacturers is the long IrDA test bottleneck on the production line. They usually use the commercially available IrDA-compliant application software or even the non-IrDA compatible file transfer software. To shorten the test time, they use very short test file. The problem is long test time (~1 minute), no easy reading and unreliable test of error rate at different speeds, no parameter re-setting by QA engineer, no isolation of send or receive problem, no automatic recording of test results. Recently, there are specific IrDA system hardware test software available to solve all these critical problem. Example is ACTiSYS's [ACT-IR900SW](#) which requires 5~10 sec. per test system

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InfraRed testing for ACTiSYS IrDA Serial Adaptor, ACT-IR200L
IR9000 demo Ver. 1.08 Copyright (c) 1995, ACTiSYS Corp. All rights reserved
ACTiSYS Corp. Tel:(510)490-8024 Fax:(510)623-7268 E-mail: corp@actisys.com
-----
Testing Speeds (BPS):  9600  19200  57600  115200  1152K  4M
Number of Packets:    10
Test Packet Size(Byte): 1024
BER Testing Pattern:  #100  #200  #300  #400
Pass Error Rate(%):   10.00  Error Rate Factor: 1.00
Transfer Direction:   COM1 <=> COM2  Beeper: ON
-----
Testing speed:        4M bps  (Demo Version. Fixed At 57600bps)
Transfer Direction:   COM1 <=> COM2
Testing Pattern:      #400
Error Rate Send(%):   N/A
Total bytes transferred: 491520  Error Rate Receive(%): 5.000
Error Packets:        2          Total Packets: 480
                          Number of Packets: 40
-----
PPPP AAA SSSS SSSS 9600 bps: Send 100.00 % Receive 92.50 %
P P A A S S S 19200 bps: Send 97.50 % Receive 97.50 %
PPPP AAAA SSSS SSSS 57600 bps: Send 100.00 % Receive 95.00 %
P A A A S S S 115200 bps: Send 97.50 % Receive 92.50 %
P A A SSSS SSSS 1152K bps: Send 95.00 % Receive 100.00 %
P A A SSSS SSSS 4M bps: Send 97.50 % Receive 95.00 %
```

to automatically print and record the error rates. It has special test patterns to exercise stress test on IrDA hardware. It can even test both IrDA and ASK modes. Its extension, IR9000SW will test IrDA-1.1 enabled system hardware and is being tested on the newly available IrDA-1.1 adapters.

Conclusion

We have described here the basics of IrDA-1.0 and IrDA-1.1 protocol, system implementation, external connection and system hardware testing. The components for both IrDA generations will become easily available and their cost reduced very quickly. The percentage of IrDA-enabled mobile and desktop computers will increase very quickly. This will expand soon into the various vertical markets of non-computer industries. The IrDA-compliant application software, the protocol stacks for controller environment and system hardware testing software have been the show stopper. This situation is improving quickly and should accelerate the rate of IrDA implementation into new systems. Many new IrDA applications in video conferencing, ISDN-, PBX-link will also emerge. The new challenge for IrDA community is the incorporation of and co-existence with consumer IR (usually longer distance, higher power and lower baud rate) applications and future higher speed (perhaps 15 Mbps or higher) extension.